Motion Imagery Standards Board	**MISB EG 0809**
Engineering Guideline	**9 December 2008**
KLV Representation of Meteorological Data	

1 Scope and Introduction

The purpose of this Engineering Guideline is to define KLV metadata elements to convey meteorological information and a metadata construct for the efficient expression of these KLV elements.

Advanced Geospatial Intelligence (AGI) (also known as Imagery Derived MASINT) entails the quantitative analysis of imagery sensor data. Since NGA is functional manager for the DoD/IC/NSG for both AGI and motion imagery, it stand to reason that AGI techniques will be applied to motion imagery. Fundamental to almost all AGI techniques is the characterization of the atmosphere between an observed object/activity and the sensor that records it. This EG provides both the language with which to describe the atmosphere and the mechanisms to convey that knowledge.

There is no intent in this document to imply the exploitation of any particular phenomenology in any specific region(s) of the electromagnetic spectrum. Rather, this document establishes the means to describe and convey a broad range of basic information about the atmosphere that should be applicable to many purposes.

2 References

The following references assist in understanding the intent of this EG and the keys defined herein:

Range Commanders Council Document 351-97, A Glossary of Selected Meteorological Terms, June 1997.

3 Metadata Keys

Thirty-five new metadata keys are defined in this EG. Four keys previously defined (See Table 1) are also used in the Meteorological Metadata Local Data Set (MM LDS) defined in § 4.

3.1 Previously Established Keys

3.1.1 POSIX Microseconds

Key Name: POSIX Microseconds
Key Number: 06 0E 2B 34 01 01 01 03 07 02 01 01 01 05 00 00
Data Type: UINT64

Data Format: Bitwise mapping of 64 bit timecode into 8 bytes
Length: 8 bytes

See *SMPTE RP 210.11* for further details.

3.1.2 Version Number

Key Name: Version
Key Number: 06 0E 2B 34 01 01 01 01 0E 01 02 05 04 00 00 00
Data Type: UINT16
Data Format: 0x00 (For EG 0808.0; a future version EG 0808.1 would be 0x01)
Length: 2 bytes

See *MISB Standard 0102.5* for further details.

3.1.3 Device Latitude

Key Name: Device Latitude
Key Number: 06 0E 2B 34 01 01 01 03 07 01 02 01 02 04 02 00
Data Type: Floating point
Data Format: +90 degrees (North Pole) to -90 degrees
Length: 8 bytes

See *SMPTE RP 210.11* for further details.

3.1.4 Device Longitude

Key Name: Device Longitude
Key Number: 06 0E 2B 34 01 01 01 03 07 01 02 01 02 06 02 00
Data Type: Floating point
Data Format: +/- 180 degrees (East Positive)
Length: 8 bytes

See *SMPTE RP 210.11* for further details.

3.2 New Keys

3.2.1 Reporting ID

This is the name/location of the entity providing the meteorological data.

3.2.2 Barometric Pressure

Atmospheric pressure as measured by a barometer using a column of liquid.

3.2.3 Black Globe Temperature

Temperature of a dry bulb inside a black copper sphere (usually 150 mm in diamter). Use to calculate effects of solar radiation and wind on apparent temperature.

3.2.4 Wet Bulb Temperature Heat Index

A composite temperature used to estimate the effect of temperature, humidity, and solar radiation on people. Consists of weighted sum of Web Bulb Temperature (0.7), Dry Bulb Temperature (0.1), and Black Globe Temperature (0.2).

3.2.5 Cloud Cover Percentage

The portion of the celestial dome which is obscured by cloud; described by the terms clear (0/10), scattered (1/10 to 5/10), broken (6/10 to 9/10), and overcast (10/10).

3.2.6 Cloud Sky Cover Type

Qualitative description of cloud cover (*e. g.*: "cirrus").

3.2.7 Cloud Base Height

Mean Sea Level (MSL) elevation of base of cloud base in meters.

3.2.8 Cloud Top Height

MSL elevation of cloud deck in meters.

3.2.9 Cloud Thickness

Difference between Cloud Top Height and Cloud Base Height.

3.2.10 Carbon Dioxide Concentration

Atmospheric CO_2 concentration in parts per million (ppm).

3.2.11 Ozone Concentration

Atmospheric O_3 concentration in parts per million (ppm).

3.2.12 Temperature

Atmospheric temperature in Celcius.

3.2.13 Dry Bulb Temperature

The temperature of the air as measured by the dry-bulb thermometer of a psychrometer.

3.2.14 Wet Bulb Temperature

The temperature a parcel of air would have if cooled adiabatically to saturation at constant pressure by evaporation of water into it with all latent heat supplied by the parcel.

3.2.15 Relative Humidity

The ratio of the partial pressure of water vapor in the atmosphere to the partial pressure of water vapor for a saturated atmosphere at a given temperature.

3.2.16 Dew Point

1. The temperature to which a given parcel of air must be cooled at constant pressure and constant water-vapor content for saturation to occur. When this temperature is 0 ºC, it is sometimes call the Frost Point.

2. The temperature at which the saturation vapor pressure of the parcel is equal to the actual vapor pressure of the contained water vapor.

3.2.17 Temperature Lapse Rate

The negative of the rate of change of temperature with respect to altitude (-dT/dz) in dry, unperturbed air.

3.2.18 Lighting Conditions

Qualitative description of lighting conditions generally including time of day ("dawn," "pre-dawn") and cloud conditions ("partly cloudy").

3.2.19 Ambient Light Color Temperature

The color temperature of the ambient scene in Kelvin.

3.2.20 Visibility Conditions

Qualitative description of visibility conditions ("clear," "haze," *etc.*)

3.2.21 Visibility

Visibility range defined by Koschmider formula in km.

3.2.22 Solar Illumination Diffuse

In Lux.

3.2.23 Solar Illumination Direct

In Lux.

3.2.24 Total Illumination Direct

In Lux.

3.2.25 Fog Presence

Boolean variable for presence of fog.

3.2.26 Fog Thickness

Fog thickness in meters.

3.2.27 Fog Cover Percentage

Percentage of scene covered with fog.

3.2.28 Fog Extinction Coefficient

The Fog Extinction Coefficient is the fraction of light lost to scattering and absorption per unit distance due to fog. It has units of 1/m.

3.2.29 Precipitation Type

Qualitative description of precipitation ("rain," "snow," *etc.*).

3.2.30 Precipitation Rate

Rate of precipitation in mm/hr.

3.2.31 R Naught

Fried's seeing parameter or transverse coherence length (in cm) at 5000 Å.

3.2.32 Theta Naught

Isoplanatic angle; the measure of how quickly atmospheric turbulence changes relative to the viewing angle as seen from a receiver. Given in micro-radians.

3.2.33 Greenwood Frequency

Measure of the temporal scale of atmospheric turbulence in Hz.

3.2.34 Rytov Parameter

Log-amplitude variance predicted by an approximate solution to Maxwell's Equations for propagation through a medium with a random Index of Refraction (unitless).

3.2.35 Tyler Tracking Frequency

First order tip/tilt tracking frequency required for an adaptive optics system. Given in Hz.

4 Meteorological Metadata Local Data Set (MM LDS)

Each instance of the MM LDS shall contain as its first element the time at which the measurement(s) were valid according to MISB RP 0603 using the POSIX Microseconds key.

Each instance of the MM LDS shall contain as its second element the Version Number of this EG from which it is constructed.

Beyond the two requirements immediately preceding, a valid instance of the MM LDS may contain any or all of the remaining tags in the MM LDS in any order desired, although each specific tag may appear only once in any instance of the MM LDS.

Table 1

Meteorological Metadata Local Data Set (MM LDS)						
Key: 06 0E 2B 34 02 2B 01 01 0E 01 03 01 0E 00 00 00						
Tag	**Name**	**Symbol/Notes**	**Key**	**Units / Range**	**Format**	**Length (Bytes)**
1	POSIX Microseconds	**This Key Defined in SMPTE RP210.11**	**06 0E 2B 34 01 01 01 03 07 02 01 01 01 05 00 00**	Integer µs since 1 Jan 1970	UINT64	8
2	Version	version; **This Key Defined in MISB Standard 0102.5**	**06 0E 2B 34 01 01 01 01 0E 01 02 05 04 00 00 00**	0x0	UINT16	2
3	Reporting ID	reporting_id; name of sensor/station producing the data in this LDS	**06 0E 2B 34 01 01 01 01 0E 01 02 03 33 00 00 00**	String	ISO 7 bit	40 max
4	Device Latitude	The latitude of the sensor/station reporting the data in this LDS; **This Key Defined in SMPTE RP210.11**	**06.0E.2B.34.01.01.01.03.07.01.02.01.02.04.02.00**	+/- 90 degrees (North positive)	Float	8
5	Device Longitude	The longitutde of the sensor/station reporting the data in this LDS; **This Key Defined in SMPTE RP210.11**	**06.0E.2B.34.01.01.01.03.07.01.02.01.02.06.02.00**	+/- 180 degrees (East Positive)	Float	8
6	Barometric Pressure	barometric_pressue	**06 0E 2B 34 01 01 01 01 0E 01 02 03 34 00 00 00**	Pascals	Float	4
7	Black Globe Temperature	black_globe_temp; Temperature inside a black colored globe	**06 0E 2B 34 01 01 01 01 0E 01 02 03 35 00 00 00**	Degrees Celsius	Float	4
8	Wet Bulb Temperature Heat Index	wet_bulb_heat_index; U. S. Army WBGT heat index	**06 0E 2B 34 01 01 01 01 0E 01 02 03 13 00 00 00**	Degrees Celsius	Float	4
9	Cloud Cover Percentage	cloud_cover_percentage	**06 0E 2B 34 01 01 01 01 0E 01 02 03 14 00 00 00**	[0 .. 100]	Float	4
10	Cloud Sky Cover Type	cloud_sky_cover_type; Description of cloud cover	**06 0E 2B 34 01 01 01 01 0E 01 02 03 15 00 00 00**	String	ISO 7 bit	40 max
11	Cloud Base Height	cloud_base_height; Height of the cloud base above mean sea level	**06 0E 2B 34 01 01 01 01 0E 01 02 03 16 00 00 00**	m	Float	4
12	Cloud Top Height	cloud_top_height; Height of cloud top above mean sea level	**06 0E 2B 34 01 01 01 01 0E 01 02 03 17 00 00 00**	m	Float	4

Meteorological Metadata Local Data Set (MM LDS)						
Key: 06 0E 2B 34 02 2B 01 01 0E 01 03 01 0E 00 00 00						
Tag	**Name**	**Symbol/Notes**	**Key**	**Units / Range**	**Format**	**Length (Bytes)**
13	Cloud Thickness	cloud_thickness; Thickness of cloud layer derived from difference of Cloud Top Height and Cloud Base Height	**06 0E 2B 34 01 01 01 01 0E 01 02 03 18 00 00 00**	m	Float	4
14	Carbon Dioxide Concentration	co2_concentration	**06 0E 2B 34 01 01 01 01 0E 01 02 03 19 00 00 00**	Parts per million	Float	4
15	Ozone Concentration	o3_concentration	**06 0E 2B 34 01 01 01 01 0E 01 02 03 1A 00 00 00**	Parts per million	Float	4
16	Temperature	temperature; atmospheric temperature	**06 0E 2B 34 01 01 01 01 0E 01 02 03 1B 00 00 00**	Degrees Celsius	Float	4
17	Dry Bulb Temperature	dry_bulb_temp	**06 0E 2B 34 01 01 01 01 0E 01 02 03 1C 00 00 00**	Degrees Celsius	Float	4
18	Wet Bulb Temperature	wet_bulp_temp	**06 0E 2B 34 01 01 01 01 0E 01 02 03 1D 00 00 00**	Degrees Celsius	Float	4
19	Relative Humidity	rel_humidity	**06 0E 2B 34 01 01 01 01 0E 01 02 03 1E 00 00 00**	[0 .. 100]	Float	4
20	Dew Point	dew_point; Temperature at which the air becomes saturated with water vapor	**06 0E 2B 34 01 01 01 01 0E 01 02 03 1F 00 00 00**	Degrees Celsius	Float	4
21	Temperature Lapse Rate	Temp_lapse_rate; Negative of actual change of temperature with altitude of a stationary atmosphere at a specific time and location	**06 0E 2B 34 01 01 01 01 0E 01 02 03 20 00 00 00**	Degrees Celsius	Float	4
22	Lighting Conditions	lighting_conditions; Clear, partly cloudy, overcast, etc. or illumination reading	**06 0E 2B 34 01 01 01 01 0E 01 02 03 21 00 00 00**	String	ISO 7 bit	40 max
23	Ambient Light Color Temperature	ambient_light_color_temp; Color temperature of the ambient scene light	**06 0E 2B 34 01 01 01 01 0E 01 02 03 22 00 00 00**	Kelvin	Float	4
24	Visibility Conditions	vis_conditions; Clear, haze, smog, dust, light fog, light rain, rain, etc.	**06 0E 2B 34 01 01 01 01 0E 01 02 03 23 00 00 00**	String	ISO 7 bit	40 max

Meteorological Metadata Local Data Set (MM LDS)						
Key: 06 0E 2B 34 02 2B 01 01 0E 01 03 01 0E 00 00 00						
Tag	**Name**	**Symbol/Notes**	**Key**	**Units / Range**	**Format**	**Length (Bytes)**
25	Visibility	visibility; Visibility range defined by MODTRAN implemtation of Koschmider formula	**06 0E 2B 34 01 01 01 01 0E 01 02 03 24 00 00 00**	km	Float	4
26	Solar Illumination Diffuse	solar_illumination_diffuse	**06 0E 2B 34 01 01 01 01 0E 01 02 03 25 00 00 00**	Lux	Float	4
27	Solar Illumination Direct	solar_illumination_direct	**06 0E 2B 34 01 01 01 01 0E 01 02 03 26 00 00 00**	Lux	Float	4
28	Total Illumination Direct	total_illumination_direct	**06 0E 2B 34 01 01 01 01 0E 01 02 03 27 00 00 00**	Lux	Float	4
29	Fog Presence	fog_presence	**06 0E 2B 34 01 01 01 01 0E 01 02 03 28 00 00 00**	N/A	Boolean	1
30	Fog Thickness	fog_thickness	**06 0E 2B 34 01 01 01 01 0E 01 02 03 29 00 00 00**	Meters	Float	4
31	Fog Cover Percentage	fog_cover_percentage	**06 0E 2B 34 01 01 01 01 0E 01 02 03 2A 00 00 00**	[0..100]	Float	4
32	Fog Extinction Coefficient	fog_extinction_coef	**06 0E 2B 34 01 01 01 01 0E 01 02 03 2B 00 00 00**	1/m	Float	4
33	Precipitation Type	precipitation_type; Rain, snow, etc.	**06 0E 2B 34 01 01 01 01 0E 01 02 03 2C 00 00 00**	String	ISO 7 bit	40 max
34	Precipitation Rate	precipitation_rate	**06 0E 2B 34 01 01 01 01 0E 01 02 03 2D 00 00 00**	mm/hr	Float	4
35	R Naught	r0; Fried's seeing parameter or transverse coherence length (5000 Angstrom wavelength assumed)	**06 0E 2B 34 01 01 01 01 0E 01 02 03 2E 00 00 00**	cm	Float	4
36	Theta Naught	theta0; Isoplanatic angle; measure of how quickly atmospheric turbulence changes relative to the viewing angle as seen from a receiver	**06 0E 2B 34 01 01 01 01 0E 01 02 03 2F 00 00 00**	micro-radians	Float	4
37	Greenwood Frequency	greenwood_freq; Measure of the temporal scale of atmospheric turbulence	**06 0E 2B 34 01 01 01 01 0E 01 02 03 30 00 00 00**	Hz	Float	4

Meteorological Metadata Local Data Set (MM LDS)						
Key: 06 0E 2B 34 02 2B 01 01 0E 01 03 01 0E 00 00 00						
Tag	**Name**	**Symbol/Notes**	**Key**	**Units / Range**	**Format**	**Length (Bytes)**
38	Rytov Parameter	rytov_parameter; Log-amplitude variance predicted by an approximate solution to Maxwell's Equations for propagation through a medium with a random Index of Refraction	**06 0E 2B 34 01 01 01 01 0E 01 02 03 31 00 00 00**	N/A	Float	4
39	Tyler Tracking Frequency	tyler_tracking_freq; First order tip/tilt tracking frequency required for an adaptive optics system	**06 0E 2B 34 01 01 01 01 0E 01 02 03 32 00 00 00**	Hz	Float	4

5 Glossary

AGI	Advanced Geospatial Intelligence
DoD	United States Department of Defense
EG	Engineering Guideline
IC	Intelligence Community
KLV	Key-Length-Value
LDS	Local Data Set
MASINT	Measurement and Signatures Intelligence
MI	Motion Imagery
MSL	Mean Sea Level
MM LDS	Meteorological Metadata Local Data Set
NGA	National Geospatial-Intelligence Agency
NSG	National System for Geospatial-Intelligence
PPM	Parts per Million